US006659143B1

(12) **United States Patent**
Taylor et al.

(10) **Patent No.: US 6,659,143 B1**
(45) **Date of Patent: Dec. 9, 2003**

(54) **VAPOR RECOVERY APPARATUS AND METHOD FOR GASOLINE DISPENSING SYSTEMS**

(75) Inventors: **Ken W. Taylor**, Oakridge, NC (US); **Robert G. McKinney**, Houston, TX (US)

(73) Assignee: **Dresser, Inc.**, Addison, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/161,162**

(22) Filed: **May 31, 2002**

(51) **Int. Cl.**[7] **B65B 1/04**
(52) **U.S. Cl.** **141/59**; 141/45
(58) **Field of Search** 141/44–46, 59

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,290,781	A		9/1981	Wang	55/17
5,217,051	A		6/1993	Simpson et al.	141/59
5,850,857	A		12/1998	Simpson	141/59
5,904,189	A	*	5/1999	Berger et al.	141/59
5,904,472	A	*	5/1999	Olson et al.	417/405

* cited by examiner

Primary Examiner—Steven O. Douglas
(74) *Attorney, Agent, or Firm*—Fish & Richardson P.C.

(57) **ABSTRACT**

An apparatus and method for recovering vapor during the dispensing of gasoline via a hose into a vehicle tank, according to which a turbine disposed in a vapor passage and is activated in response to the dispensing of the gasoline for drawing the vapor from the tank and into the vapor passage. Blades on the turbine separate the air from the gasoline vapor. The vapor is returned to the liquid stream and the air discharged to atmosphere. The apparatus therefore does not require vapor return piping to the underground tanks.

20 Claims, 3 Drawing Sheets

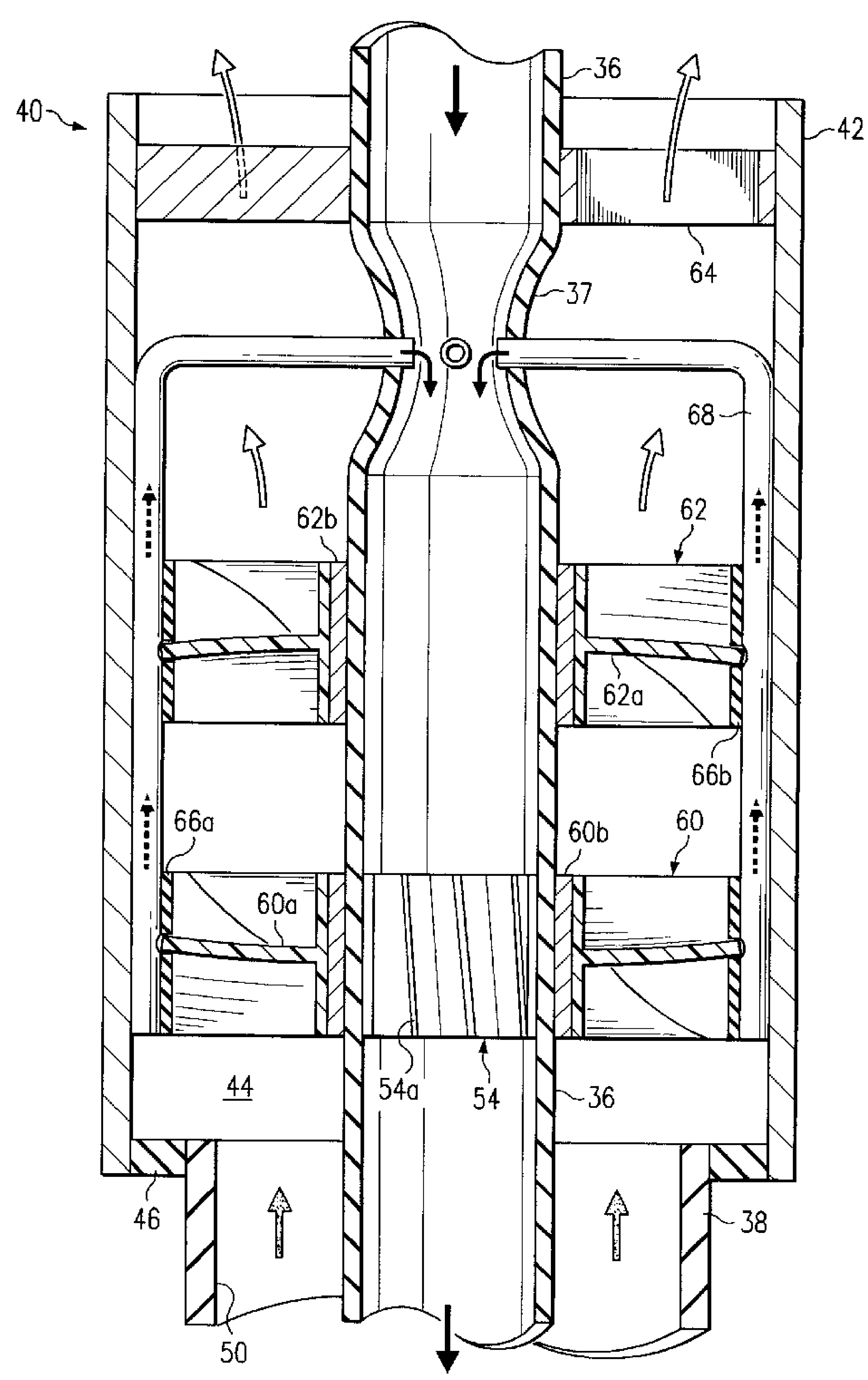
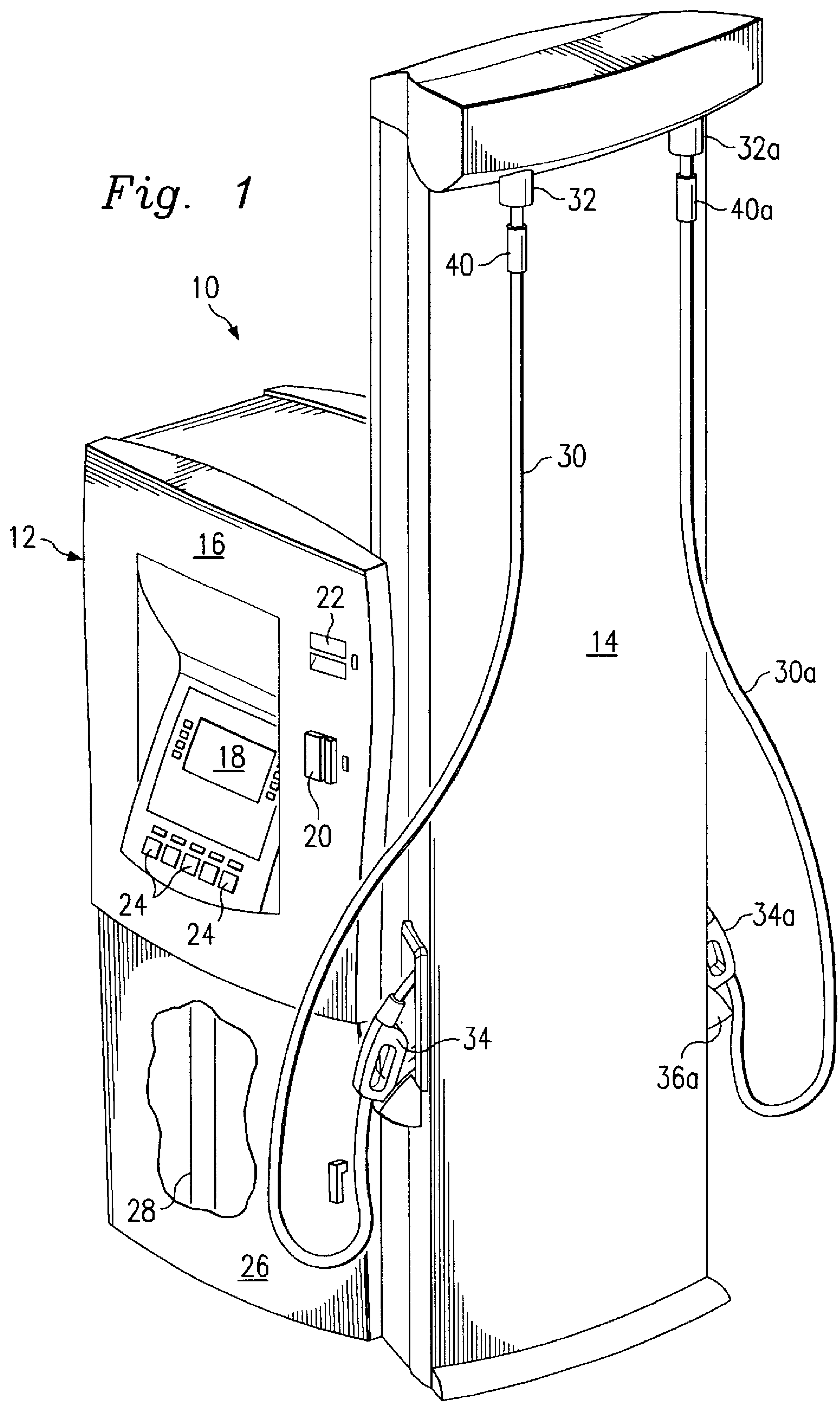


Fig. 1



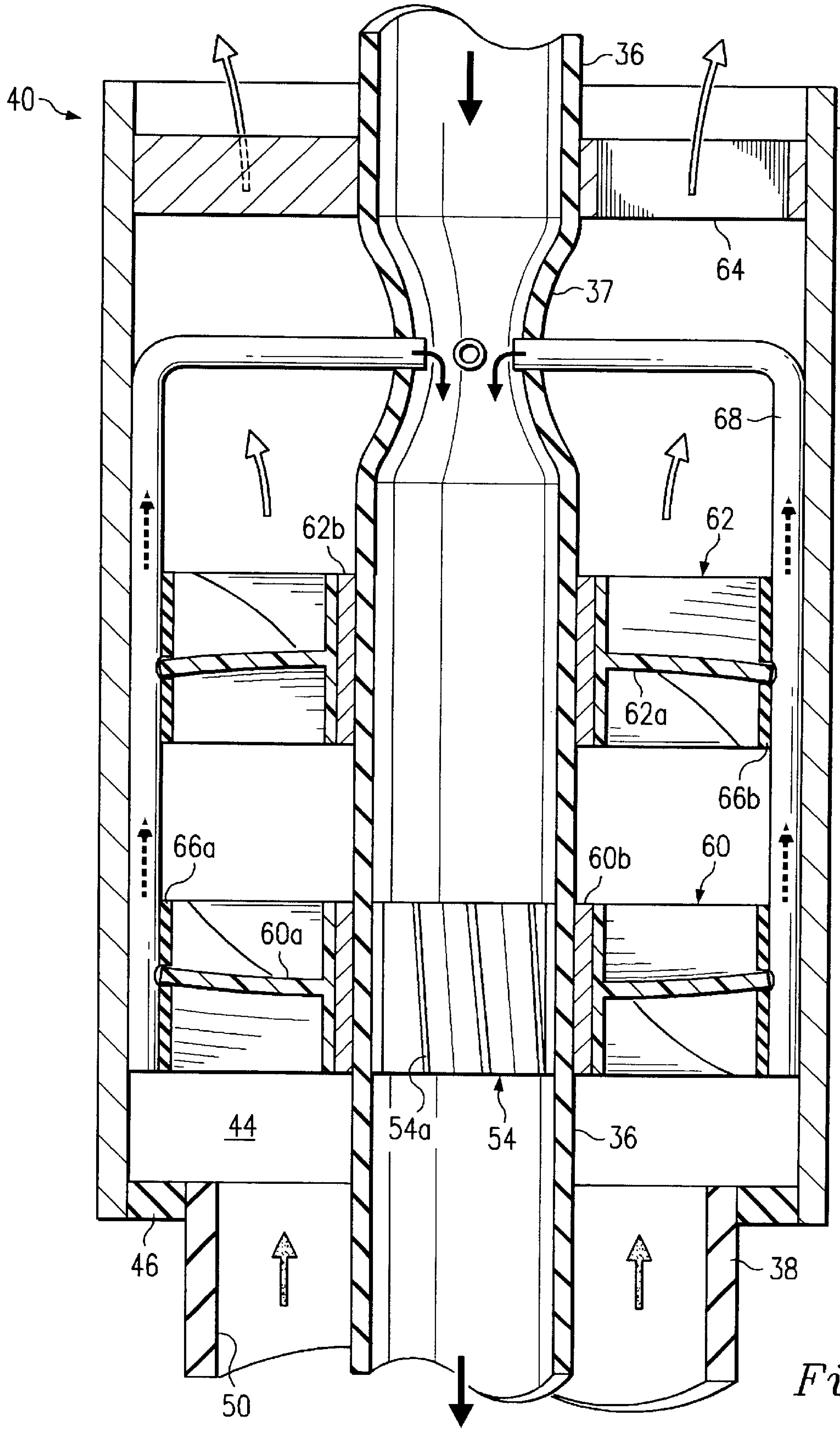


Fig. 2

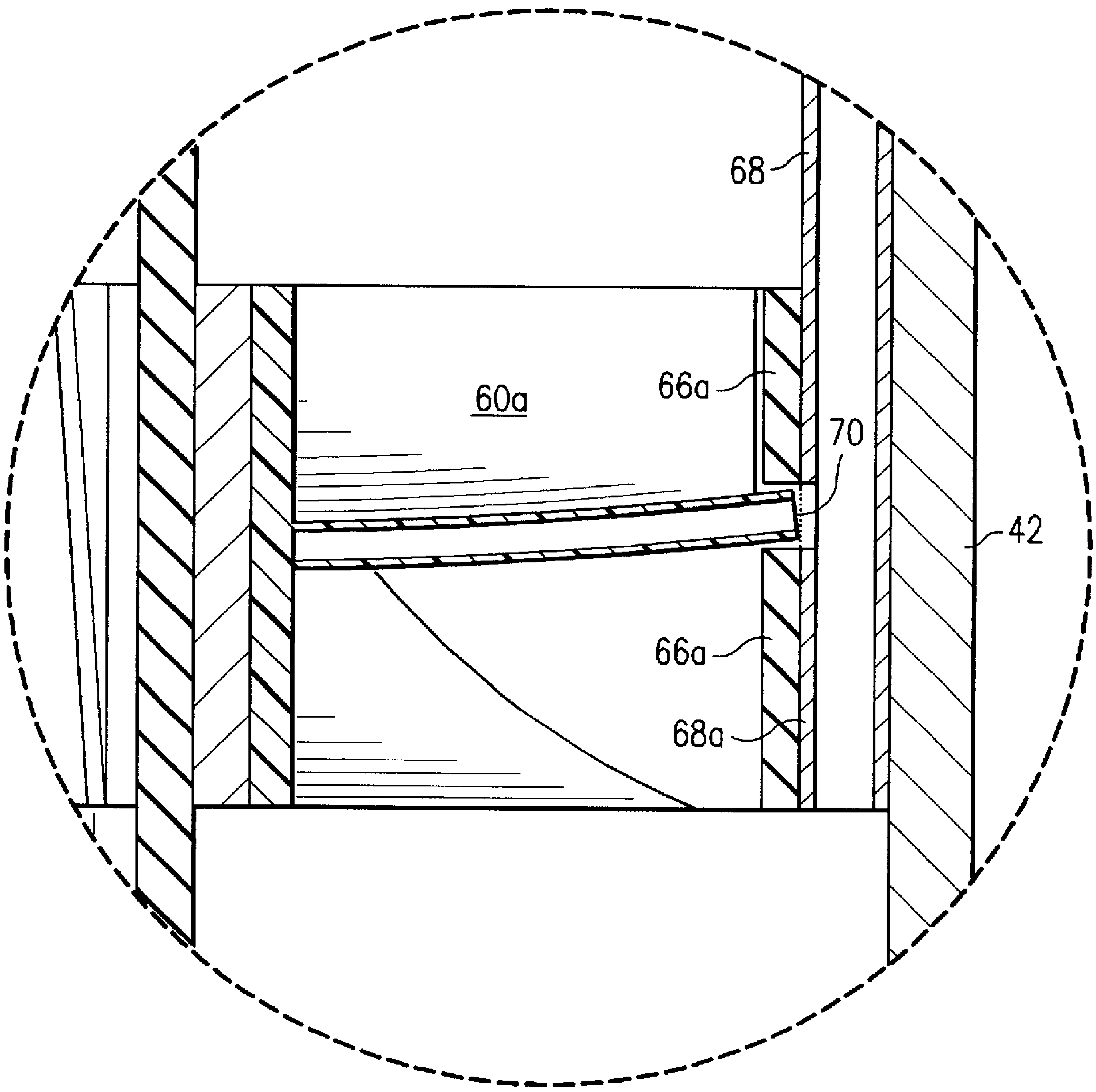


Fig. 3

VAPOR RECOVERY APPARATUS AND METHOD FOR GASOLINE DISPENSING SYSTEMS

BACKGROUND

This invention relates to a vapor recovery apparatus and method and, more particularly to such an apparatus and method for recovering gasoline vapors from a gasoline dispensing systems.

In a gasoline service station for dispensing gasoline to vehicles, several gasoline dispensing units, or pumps, are provided which receive gasoline stored in one or more underground storage tanks and dispense the gasoline, via dispensing nozzles, to the vehicles.

In these arrangements, gasoline vapor is present in the fuel tank of the vehicle and released from the gasoline flow which can discharge to atmosphere if not properly recovered. In compliance with government regulations that require this gasoline vapor to be recovered, various types of systems have evolved.

By far the most common recovery systems of this type utilize a dual hose arrangement with one hose supplying the gasoline from the underground storage tank to the dispensing nozzle for dispensing into the vehicle, and the other hose passing the gasoline vapors from the vehicle tank to the underground storage tank. With all currently known vapor recovery systems of this type, extensive vapor return piping, along with associated pumps and valves, are required to conduct the collected vapor from the vehicle tank, through the dispensing unit and back to the underground storage tank. Of course, in relatively old installations, if this piping has not been provided during the initial construction, the station forecourt has to be dug up to install the underground portion of the system, which considerably adds to the cost of the installations.

Therefore what is needed is a vapor recovery system that eliminates the need to transfer the recovered vapors to the underground gasoline storage tank, and therefore eliminates the cost and complexity of such systems.

SUMMARY

The present invention is directed to an apparatus and method for recovering vapor during the dispensing of fuel via a hose into a vehicle tank. An embodiment of the invention has a compressor disposed in a vapor passage. The compressor is activated in response to the dispensing of the fuel for drawing the vapor from the tank and into the vapor passage. Blades on the compressor separate the air from the gasoline vapor. The recovered vapor is reintroduced into the fuel flow and the air is released to the atmosphere.

An advantage of the invention is that it operates by motion of the fluid flow to the vehicle tank, and therefore saves on electrical power cost because no electrical power is needed.

An advantage of the invention is that recovered vapor can be reintroduced back into the fuel stream at the fuel hose, thereby eliminating a lengthy fluid path back to the source fuel tank. This reduces the susceptibility of the system to leaks, for example in the dispenser itself, in the underground pipes, or at the fuel tank or tank vent. Also, because the recovered vapor is not routed to the fuel tank, it does not pressurize the fuel tank.

These and other advantages of the invention will be come apparent from the following Drawings and Description of the Preferred Embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view of a gasoline dispensing unit employing vapor recovery apparatus according to an embodiment of the present invention.

FIG. **2** is an enlarged, cross-sectional view of the vapor recovery apparatus of the embodiment of FIG. **1**.

FIG. **3** is an enlarged portion of the component of FIG. **2**.

DESCRIPTION OF A PREFERRED EMBODIMENT

With reference to FIGS. **1** and **2** of the drawings, the reference numeral **10** refers, in general, to a gasoline dispensing unit consisting, in general, of a dispenser housing **12**, and a hose tower **14** extending to one side of the housing.

The housing **12** includes a front bezel, or panel, **16**, a side portion of which overlaps a portion of the hose tower **14**. The center portion of the panel **16** is slightly recessed and includes a display **18** for displaying information relating to the gasoline dispensing operation. A credit card reader **20** and a receipt dispenser **22** are provided to the side of the display **18**, and a series of octane select buttons **24** are mounted below the display **18**.

A door **26** extends over a compartment in the lower portion of the housing **12** below the panel **16** which receives hydraulics including a conduit **28** that extends to an underground storage tank for the gasoline to be dispensed. Although not shown in the drawings, it is understood that the conduit **28** also extends to the hose tower **14** for passing gasoline to one end of a hose assembly **30** which extends from a fitting **32** at the upper portion of is the tower. A nozzle **34** is connected to the other end of the hose assembly **32** for dispensing the gasoline to a vehicle.

A hose assembly **30***a* extends from a fitting **32***a* extending from the upper portion of the tower **14**, and receives a nozzle **34***a* The hose assembly **30***a* and the nozzle **34***a* are similar to the hose assembly **30** and the nozzle **34**. Although not shown in the drawing, it is understood that the dispenser housing **12** has a rear panel that receives similar components as the panel **16** which are associated with the hose assembly **30***a* and which function in a similar manner to the latter components.

A pump (not shown) is provided for pumping the gasoline from the storage tank to the conduit **28** when the unit **10** is activated, so that the gasoline flows through the conduit **28** and the hose assembly **30** to the nozzle **34** which can be manually activated for dispensing the fuel into the gasoline tank of a vehicle. The nozzle **34** also has an inlet for receiving a mixture of gasoline vapor and air from the latter tank during the dispensing of the gasoline, which mixture is processed in a manner to be described.

As shown in FIG. **2**, the hose assembly **32** includes an inner hose **36** and an outer hose **38** extending over, or around, a portion of the inner hose. The inner hose **36** receives gasoline from the conduit **28** (FIG. **1**) and passes it to the nozzle **34** in a direction shown by the solid-line arrow in FIG. **2**. A portion of the inner hose **36** has a reduced-diameter portion to form a venturi section **37** for forming a reduced pressure zone for reasons to be described.

A separator unit **40** extends over a portion of the inner hose **36** near the fitting **32**, and includes an casing **42** which is greater than the outer diameter of the inner hose **32***a* to form an annular chamber **44**. The casing **42** is preferably circular in cross section and includes a first truncated, frusto-conical portion **42***a* that is tapered inwardly in a direction away from the hose tower **14** (FIG. **1**); and a second truncated frusto-conical portion **42***b* that extends from the portion **42***a*, and is tapered outwardly in the same direction.

The upper end of the casing portion **42***a* is open, and an annular coupling plate **46** is attached to the lower end of the casing portion **42***b*. The inner hose **36** extends through the casing **42**, and the corresponding end of the outer hose **38** is coupled to the plate **46** and extends over the inner hose **36** from the plate to the nozzle **34**. The inner diameter of the outer hose **38** is greater than the outer diameter of the inner hose **36** to form an annular, vapor recovery, passage **50** which receives gasoline vapor from the vehicle tank, via the nozzle, during the dispensing of the gasoline.

A turbine **54** is mounted for rotation in the inner hose **36**, and has a plurality of blades **54***a* extending from a central shaft. The blades **54***a* are in the path of the gasoline flowing through the inner hose **36** so that the fluid causes rotation of the turbine.

A compressor **60** is rotatably mounted in the chamber **44** and extends around the downstream end portion of the turbine **54**. The compressor **60** includes a plurality of concave, porous, and hydrodynamically smooth blades **60***a* extending from a hollow shaft **60***b* that surrounds the inner hose **36**. The blades **60***a* are arranged in an opposite direction to the blades **56** of the turbine **54** and are hollow to form a passage for receiving vapor that passes through the porous walls of the blades as will be described. The compressor **60** is magnetically coupled to the turbine **54** so that the above rotation of the turbine **54** causes corresponding rotation of the compressor **60**.

A rotor **62** is also rotatably mounted in the chamber **44** and extends around the upstream end portion of the turbine **54** in a spaced relation to the compressor **60**. The rotor **62** includes a plurality of concave, porous, and hydrodynamically smooth blades **62***a* extending from a hollow shaft **62***b* that surrounds the inner hose **36**. The blades **62***a* are also arranged in an opposite direction to the blades **54***a* of the turbine **54** and are also hollow to form a passage for receiving vapor that passes through the porous walls of the blades as will be described. The rotor **62** is free-spinning, and a stator **64** is mounted to the exterior surface of the casing **42** in radial alignment with the rotor **62**. The stator **64** interacts aerodynamically with the rotor in a manner to be described.

The turbine **54** is mounted in the inner hose **26**, and the compressor **60** and the rotor **62** are mounted in the chamber **44**, in a manner to enable them to rotate about their respective longitudinal axes while being restrained against axial movement. This mounting of the turbine **54**, the compressor **60** and the rotor **62**; as well as the magnetic coupling between the turbine and the compressor and rotor are done in a conventional manner such as disclosed in U.S. Pat. No. 5,217,051 the disclosure of which is incorporated by reference.

Two axially-spaced, annular ring seals **66***a* and **66***b* are provided at the radial outer edges of the compressor blades **60***a* and the rotor blades **62***a*, respectively, and are attached to the blades in any know manner. An annular collector **68** has a portion extending along the inner wall of the casing portion **42***b* in alignment with the ring seals **66***a* and **66***b*.

As better shown in FIGS. **3** and **4** in connection with one of the blades **60***a* of the compressor **60**, a nipple **70** is formed on the outer edge of each blade **60***a* and extends though a slot formed in the seal ring **66***a* and to a port **68***a* formed in the collector **68**. The end of the nipple **70** is porous so that vapor collected in the interior of each blade **60***a* passes through the corresponding nipple, and into the collector **68**. Although not shown in FIG. **3**, it is understood that nipples, similar to the nipple **70**, are provided on the remaining blades **60***a* of the compressor **60** and on all of the blades **62***a* of the rotor; and that corresponding slots are provided in the seal rings **66***a* and **66***b*, and corresponding ports are provided in the collector **68**.

The remaining portion of the collector **68** extends axially upstream from the portion of the collector discussed above, and then radial inwardly to the venturi section **37** of the inner hose **36**. The aforementioned rotatable seal formed by the ring seals **66***a* and **66***b* and the collector **68** confines the axial movement of vapor through the collector.

In operation, gasoline is pumped from the storage tank, through the conduit **28** (FIG. **1**) to the hose tower **14**, and through the inner hose **36** to the vehicle to be serviced, in the direction indicated by the solid arrow in FIG. **2**. The turbine **54** thus rotates in proportion to the flow of gasoline through the hose **36** by virtue of the forces applied by the gasoline to the blades **54***a*. Due to the magnetic coupling between the turbine **54** and the compressor **60**, the compressor rotates in the chamber **44** in a direction opposite the direction of rotation of the turbine.

The rotation of the compressor **60** creates forces that draw a mixture of air and gasoline vapors from the vehicle tank through the nozzle **34**, into and through the passage **50**, and into the chamber **44** as indicated by the dotted-dashed arrows in FIG. **2**.

The air/vapor mixture in the chamber **44** is compressed by the compressor **60** and a portion of the relative light air of the mixture is separated from a portion of the relatively heavy vapor due to the vapor layering, by molecular weight, on the smooth, porous surfaces of the compressor blades **60***a*. The separated vapor, which consists largely of hydrocarbons, passes through the pores of the blades **60***a* into the interior of the blades, and through the nipples **70** of each blade, before passing through the ports **68***a* of the collector **68** and into the interior of the collector, with this movement being assisted by the centrifugal force of the motion of the blades **60***a*.

The remaining portion of the mixture and the separated air from the above first-stage separation passes to the rotor **62**, with the force of the mixture and the air on the blades **62***a* of the rotor causing it to rotate in a direction opposite the direction of rotation of the compressor. A second-stage separation of the relative light air from the relatively heavy vapor of a portion of the mixture occurs by the vapor components of the mixture layering, by molecular weight, on the smooth, porous surfaces of the rotor blades **62***a*. The separated vapor, which consists largely of hydrocarbons, passes through the pores of the blades **62***a*, into the interior of the blades, and through the nipples of each blade, before passing through the ports of the collector **68** and into the interior of the collector, with this movement being assisted by the centrifugal force of the motion of the blades **62***a*. During this separation, the stator **64** interacts aerodynamically with the rotor **62** in a manner to reduce turbulence and promote laminar flow of the air/vapor mixture along the surface of the blades **62***a* to promote the separation.

The low pressure caused by the venturi section **37** of the inner hose **36** provides a suction train that promotes permeation of vapor through the porous blades **60***a* and **62***a*, through the ports **68***a* of the collector **68**, and through the collector, as described above. The venturi section **37** of the inner hose **36** is also porous so that the vapor passes from the collector **68** into the interior of the hose. In the hose **36** the collected vapor mixes with the gasoline flowing through the hose and is thus reintroduced into the vehicle. The separated air is discharged through the open end of the casing portion **42***a* as shown by the dotted arrows.

Therefore, the above embodiment eliminates the need for costly and complex vapor recovery systems that require transferring the recovered vapor from the vehicle tank to the gasoline storage tank.

It is understood that variations may be made in the foregoing without departing from the scope of the invention. For example, it is understood that one or more additional rotor/stator sets can be used as needed to accomplish substantially complete separation of the gasoline vapors from the air. Also, the terms "hose", "conduit", "passage" etc. are not limited to any particular fluid flow device but are equally applicable to all such devices. Also, spatial references, such as "upper", "lower", etc. are for the purpose of illustration only and do not limit the specific orientation or location of the structure described above

Since other modifications, changes, and substitutions are intended in the foregoing disclosure, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

What is claimed is:

1. A vapor recovery method comprising flowing gasoline through a hose and into a vehicle tank, establishing a passage connected to the vehicle tank, activating a compressor in the passage in response to the dispensing of the gasoline so that the compressor draws a mixture of gasoline vapor and air from the tank and into the passage, separating the air from the vapor in the vapor passage, and recycling the separated vapor back into the gasoline flowing through the hose.

2. The method of claim **1** further comprising discharging the separated air to atmosphere.

3. The method of claim **1** wherein the step of establishing comprises providing an outer hose extending over, and in a spaced relation to, the first-mentioned hose.

4. The method of claim **1** wherein the compressor has a plurality of porous blades so that the mixture separates on the blades and the vapor passes into the interior of the blades.

5. The method of claim **4** further comprising providing a plurality of collection ports for receiving the separated vapor from the blades and passing the separated gasoline vapor to the gasoline flow through the hose.

6. The method of claim **1** further comprising providing a turbine in the hose for rotation in response to the flow of gasoline through the hose, and coupling the turbine to the compressor to activate same.

7. The method of claim **6** further comprising providing a rotor in the vapor passage so that the rotor rotates in response to the passage of the mixture through the vapor passage.

8. The method of claim **7** wherein the rotor has a plurality of porous blades so that the mixture separates on the blades and the separated vapor passes into the interior of the blades.

9. The method of claim **8** further comprising providing passing the separated vapor into and through a plurality of collection ports, and passing the separated vapor from the collection ports to the gasoline flow through the hose.

10. The method of claim **7** further comprising interacting a stator with the rotor to reduce turbulence and promote laminar flow of the air/vapor mixture along the surface of the rotor blades to promote the separation.

11. A vapor recovery device for a fuel dispensing system, comprising:

a fuel passage in communication with the fuel dispensing system and a destination for delivering fuel from the fuel dispensing system to the destination;

a recovery passage in communication with the destination for recovering vapor from the destination;

a turbine disposed within the fuel passage, wherein flow of fuel through the fuel passage causes the turbine to rotate;

a compressor in the recovery passage, the turbine and the compressor coupled such that rotation of the turbine causes rotation of the compressor, and rotation of the compressor draws vapor from the destination through the recovery passage;

a conduit in the recovery passage having a porous surface adapted to allow passage of vapor from the recovery passage into an interior of the conduit; and

a collector passage in communication with the interior of the conduit and the fuel passage to communicate vapor in the interior of the conduit to the fuel passage.

12. The vapor recovery device of claim **11** wherein the compressor has a plurality of blades and the conduit is at least one of the blades of the compressor.

13. The vapor recovery device of claim **11** further comprising a rotor in the recovery passage, the rotor having a plurality of blades and configured such that flow through the recovery passage causes the rotor to rotate, wherein the conduit is at least one of the blades of the rotor.

14. The vapor recovery device of claim **12** further comprising a rotor in the recovery passage, the rotor having a plurality of blades and configured such that flow through the recovery passage causes the rotor to rotate, wherein the conduit is at least one of the blades of the rotor and at least one of the blades of the compressor.

15. The vapor recovery device of claim **11** wherein the fuel passage has a venturi section of reduced diameter in communication with the collector passage, the venturi section configured to draw vapor through the collector passage and into the fuel passage.

16. The vapor recovery device of claim **12** wherein the collector passage is in communication with a tip of the blades and movement of vapor through the conduit is assisted by centrifugal force of the motion of the blades.

17. The vapor recovery device of claim **13** wherein the collector passage is in communication with a tip of the blades and movement of vapor through the conduit is assisted by centrifugal force of the motion of the blades.

18. The vapor recovery device of claim **11** wherein the fuel passage and the recovery passage are substantially coaxial.

19. The vapor recovery device of claim **11** wherein an end of the recovery passage opposite the destination is open to the atmosphere.

20. The vapor recovery device of claim **11** further comprising a stator in the recovery passage configured to reduce turbulence.

* * * * *